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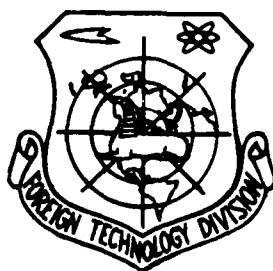


CURRENT SITUATION OF THE DEVELOPMENT AND MANUFACTURE OF VARY LARGE  
SCALE INTEGRATED DEVICES IN CHINA

by

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## CURRENT SITUATION OF THE DEVELOPMENT AND MANUFACTURE OF VARY LARGE SCALE INTEGRATED DEVICES IN CHINA

Yubiao He

China's VLSI device industry, no matter whether various memory devices, or CPU's and their interfacing devices, is still in the developmental and small-quantity production stage. However, great successes have been achieved during the sixth Five-Year-Plan. The currently achieved technological level for NMOS production lines are on the order of 4-6  $\mu\text{m}$ . A number of production lines have been developed for HMOS-I and HCMOS-I devices on the order of 2.5-3.5  $\mu\text{m}$ . It is predicted that the research and manufacture of CMOS devices will be emphasized in the future. The development of STTL and LSTTL devices, mostly medium- and small-scale, was also outstanding during the past two years. Recently developed and current on-line products of LSI (VLSI) devices are listed in the attached tables. The highest technological levels achieved presently by domestic NMOS devices are: 64K-bit DRAM (developed and manufactured by the 24th Research Institute and the 742th Factory of the Ministry of Electronic Industry

(MEI)); 16K-bit (2K-byte) single-source EPROM (47th Research Institute of MEI); 68B00 8-bit micro-processor ( $\mu$ p) (47th Research Institute of MEI); 8085 8-bit  $\mu$ p (Qinghua University and the 5th Electronic Device Factory in Shanghai). In addition, CMOS, TTL and ECL devices have achieved 1K-bit high-speed SRAM and single-chip 10-bit D/A converter (47th Research Institute of MEI) and 8-bit A/D converter.

Containing 100,000 and 150,000 elements, respectively, the 16K SRAM, developed by Qinghua University in 1985, and the 64K DRAM, jointly developed by the 47th Research Institute and the 742th Factory of MEI, are the first VLSI devices independently and successfully developed in our country, indicating that China has entered the VLSI era.

However, due to the severe constraints of manufacturing equipment, testing techniques, ultra-pure material and ultra-clean environment, the qualification rate of our LSI products are too low to be put into large-quantity production, except for a few imported production lines.

In the development and manufacture of micro-processors, CMOS 1-bit micro-processor 14500 is compatible with the MC14500 by Motorola. Due to the ease of manufacture resulting from the relative simple small-scale structure and the small number of required interfacing devices which are presently available, the 14500  $\mu$ P has now been put

into large-quantity production at the 5th Electronic Device Factory in Shanghai, the 14th Radio Factory in Shanghai, and the Semiconductor Device Factory in Beijing, etc., and has achieved an increasing number of domestic applications.

Many domestic factories/companies manufacture NMOS or PMOS, single-chip or multi-chip, 4-bit micro-processors. These products, designed domestically, are not compatible with foreign 4-bit micro-processors, which greatly limit their applications.

As for 8-bit micro-processors, the 8080A, developed by the 5th Electronic Device Factory in Shanghai, and the 8085, jointly developed by Qinghua University and the 5th Electronic Device Factory in Shanghai, have been qualified. Some series of interfacing devices have also been developed. However, due to the incompleteness of the required interfacing devices, especially large-scale integrated interfacing devices, those micro-processors mentioned above have not yet been put into mass production.

The 6800 Series 8-bit micro-processors, which have been put into production at several factories, are mainly developed by the 47th Research Institute of MEI. In addition to the 6800, 68A00 and 68B00 micro-processors, that Institute has also successfully developed a variety of rather complete series of interfacing devices, and therefore are ready for industrial production. This is a major

achievement in the research and development of VLSI devices during the sixth Five-Year-Plan period.

The manufacture of LSI and VLSI devices in foreign countries is a highly competitive high-tech industry. It requires high-precision manufacturing technology, and very expensive manufacturing equipment. Therefore, it is impossible to conduct research and form industrial production capability by merely relying on obsolete manufacturing equipment and semi-manual production techniques. According to the experience of our foreign counterparts and based on our current situation, it is highly desirable for domestic LSI and VLSI research institutes and manufacturers to establish unified development-manufacturing units, concentrate resources, amass available funds to upgrade equipment and technology, improve management, conduct theoretical research, and develop new technology and new devices under a unified planning and assigned responsibility. It is only in this way that we can reduce the gap between domestic and foreign VLSI device industries, and promote our micro-electronic industry. This should be the trend for the development of the micro-electronic industry in China.

Table 1. Static random access memory (SRAM)

Domestic Product	Foreign Product	Size (bit)	Technology	Accessing Time (ns)	Cycle Time (ns)
W6810	MCM6810	128x8	NMOS	575	575
LN6810	"	"	"	250	370
"	"	"	"	360	360
5G2102	2102	1kx1	"	250	250
DG2102	C2102	"	"	450	450
W2115	2115	"	HMOS	45	45
DG2114	C2114	1kx4	NMOS	450	450
W2114	2114	"	"	350	350
5G2114	"	"	"	200	200
W2147	2147	4kx1	HMOS	70	70
16KSRAM		2kx8	"		
5G5101	MCM145101	256x4	CMOS	450	450
IM6508	IM6508	1kx1	"	300	300
HCM6562		256x4	HCMOS	75	75
93415	93415	1kx1	TTL	45	
MCM10146	MCM10146	"	ECL	25	

Table 2. Dynamic random access memory (DRAM)

Domestic Product	Foreign Product	Size (bit)	Technology	Accessing Time (ns)	Cycle Time (ns)
DG0031		4kx1	NMOS	450	695/500
DG4027	MCM4027	"	"	250	375
CN2107		"	"	400	600
W4116	MCM4116	16kx1	HMOS	375	700
4864	4864	64kx1	"	(200)	(300)

Table 3. Read-only memory (ROM) and erasible read-only memory (EPROM) (NMOS devices)

Domestic Product	Foreign Product	Function	Size (bit)	Read time (ns)	Cycle Time (ns)
LN6830	MCM6830	Fixed ROM	1kX8	300	350
LN6830A	"	"	"	350	
W6830	"	"	"	500	500
LN2708	MCM2708	EPROM	"	350	
I2708	i2708	"	"	450	
5G2708	"	"	"	450	
DG2708	MCM2708	"	"	450	
LN2716	MCM2716	"	2kX8	450	
DG0016		Character generator	5X7matrix 64 char.		
DG0015		"	5X7matrix 96 char.		
LN6674		"	5X7matrix 128 char.		

Table 4. General medium- and small-scale LSTTL interfacing devices

Product	Device name and function
74LS125	4-bit bus buffer (three-state, non-inverting)
54LS125	"
74LS126	"
54LS126	"
74LS365	6-bit bus driver (three-state, non-inverting)
54LS365	"
74LS366	6-bit bus driver (three-state, inverting)
74LS367	6-bit bus driver (three-state, non-inverting)
54LS367	"
74SS368	6-bit bus driver (three-state, inverting)
54LS368	"
74LS240	8-bit bus driver (three-state, inverting)
74LS244	8-bit bus buffer/driver (three-state, non-inverting)
54LS244	"
74/54LS245	8-bit bus transceiver (three-state, non-inverting) n
74/54LS251	8-to-1 multiplexer/modulator (three-state)
74/54LS253	Dual 4-input multiplexer(three-state)
74/54LS257	4-channel 2-input multiplexer (three-state)

Table 5. MC14500 CMOS 1-bit micro-processor dedicated interfacing devices (CMOS)

Domestic Product	Foreign Product	Device name (function)
5G14512	MC14512	8 channel multiplexer
5G14516	MC14516	4-bit reversible binary counter with preset
5G14599	MC14599	8-bit addressable bidirectional latch

Table 6. 2901 LSTTL 4-bit single-chip computer dedicated interfacing devices

Domestic Product	Foreign Product	Device name (function)
ER2902/M	AM2902C/M	Look-ahead carry generator
ER2910/M	AM2910C/M	12-bit sequencer
ER2905/M	AM2905C/M	2-input OC bus transceiver
ER2918/M	AM2918C/M	4-bit D flip-flop

Table 7. 4-bit micro-processor interfacing devices

Product	Technology	Device name	Type of computers used for
040-5	PMOS	Clock/display	DJS-040 PMOS 4-bit computer
5205/5205A	NMOS	Sync. decoder	051 NMOS 4-bit computer
DG0046	NMOS	Programmable communication interface	DG004 and DG0401 4-bit computer

Table 8. 8080A/8085 series interfacing devices

Domestic Product	Foreign Product	Technology	Device Name (Function)
8216	i8216	STTL	4-bit bi-directional bus driver
5216/5216A		NMOS	"
8226	i8226	STTL	"
8212	i8212	"	8-bit I/O port
5212/5212A		NMOS	"
8224	i8224	STTL	Clock generator/driver
5G8251	i8251	NMOS	Universal programmable communication port (USART)
5G8253	i8253	"	Programmable timer
5G8255	i8255	"	Programmable 8-bit Parallel I/O port
5G8257	i8257	"	Programmable DMA controller
5G8259	i8259	"	Programmable interrupt controller
5G8279	i8279	"	Programmable key board/display port

Table 9. MC6800 series interfacing devices

Product	Technology	Device Name (Function)
6877/8T97	STTL	UNi-directional three-state buffer
6880A/8T26A	"	4-bit three-state bus transceiver
6875	"	6800 clock generator/driver
6820	NMOS	Peripheral interfacing adapter (PIA)
6821/A21/B21	"	"
6840	"	Programmable timer
6844	"	DMA controller (DMAC)
6845	"	CRT controller (CRTC)
6850	"	Async. communication interfacing adapter
68A50/68/B50	"	"
6852	"	Sync. series data adapter (SSDA)
68A52/68B52	"	"
6854	"	Advanced data link controller
6860	"	0-600 baud modem
6862	"	2400 baud digital modulator
68488	"	General interfacing adapter
6674	"	128 5x7 dot matrix character generator

Table 10. Single-Chip D/A Converter (DAC)

Domestic Product	Foreign Product	Resolution(bit)	Accuracy	Conversion mode	Settling time ( $\mu$ s)
X80	LM1408	8	0.19-0.78		0.3
LDA08C		8	0.2	@	0.3
LT1508	MC1508	8	0.2	@	0.3-0.4
LAZ08		8	0.2	@	0.4
FDA0808	CDAC0808	8	0.2	#	0.15
4E602		8-10	0.2	#	0.8
5G7520	AD7520	8-10	0.05		0.5
LDA3410	MC3410	10	0.05	@	0.25

Table 11. Single-Chip A/D Converter (ADC)

Domestic Product	Foreign Product	Resolution(bit)	Accuracy	Conversion mode	Settling time (ms)
5G14433	MC14433	3.5	0.05	\$	100
FMC14433	"	3.5	0.05	\$	40
CH7106	ICL7106	3.5	0.1	\$	300
FADC0808	CADC0808	8	0.5	&	0.1
5G0801	ADC0801	8	$\pm 1/4$ LSB	&	0.1
5G0802	ADC0802	8	$\pm 1/4$ LSB	&	0.1
CMOS A/DC		8	0.5	&	0.016

Note: 1. In Table 10, all DAC's are TTL except 5G7520, which is CMOS.

2. In the "Conversion Mode" column, @ indicates "current switch type", and # indicates "multiplicative type".

3. In Table 11, all ADC's are CMOS.

4. In the "Conversion Mode" column, \$ indicates "dual-integral type", and & indicates "successive comparison type".

Table 12. Micro-Processors ( $\mu$ P)

Domestic Product	Foreign Product	Bit	Technology	Basic Command	Max. Freq. (MHz)	Addressability (byte)	Interrupt Mode	No. of General Rgstr.	Stack Level	Addressing Modes
5G14500	MC14500	1	CMOS	16	1.0			1		
DH14500	"	1	"	16	1.0			1		
CH4500B/C	"	1	"	16	1.0			1		
DJS040 <sup>*1</sup>		4	PMOS	45	0.1	1k		1	1	1
DG0040 <sup>*2</sup>		4	NMOS	48	0.15	8k		1		
DG00401 <sup>*3</sup>		4	"	68	0.15	2K				
DG420		4	"	49	4.0	1K				
ER2901	AM2901C	4	LSTTL	512-micro	9.5	256/256	Multi-level		Multi level	4
ER2901A	AM2901A	4	"	"	15.0	256/256	"		"	4
ER2901M	AM2901M	4	"	"	8.3	256/256	"		"	4
ER2901AM	AM2901M	4	"	"	12.0	256/256	"		"	4
5G8080	i8080A	8	NMOS	72	2.0	64k/512	"	6	"	7
5G8085	i8085	8	"	74	3.0	64k/512	"	6	"	7
8085	i8085	8	"	74	3.0	64k/512	"	6	"	7
LN6800	MC6800	8	"	72	1.0	64k	"	6	"	7
W6800	MC6800	8	"	72	1.0	64k	"	6	"	7
DG6800	MC6800	8	"	72	1.0	64k	"	6	"	7
LN68A00	MC68A00	8	"	72	1.5	64k	"	6	"	7
LN68B00	MC68B00	8	"	72	2.0	64k	"	6	"	7

Note: \*1—two-chip CPU; \*2—CPU/RAM/ROM three-chip computer; \*3—CPU/RAM/ROM three-chip computer. All others are single-chip  $\mu$ P's.

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